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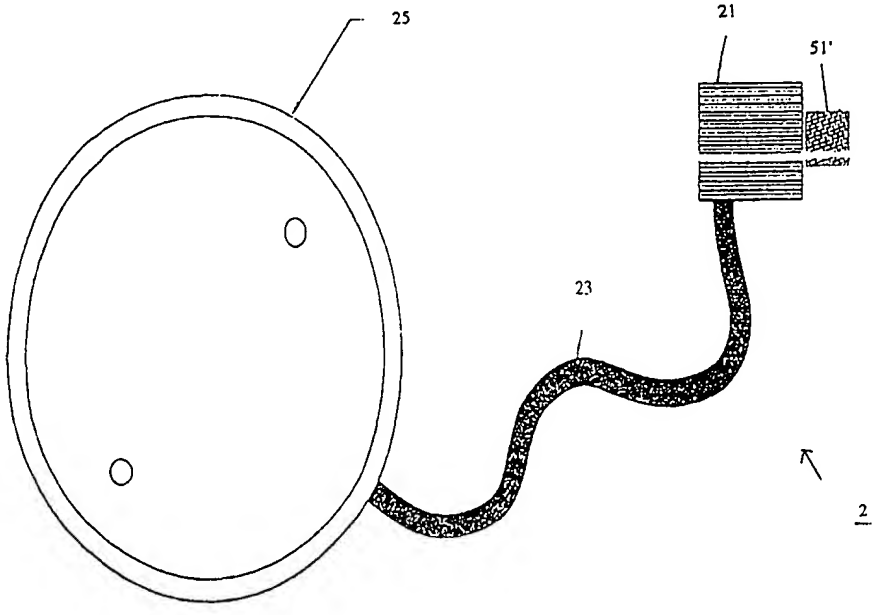

(57) Abstract

The invention provides a detection system for detecting a changed gas pressure in a tyre of a vehicle. The detection system comprises a detection unit (25) coupled to a pressure sensor (21) and a tyre valve nut (51) wherein the detection unit receives gas pressure information of the tyre and generates a detection signal and the display unit generates a display signal which depends on the detection signal.

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Detection system for detecting a gas pressure in a tyre of a vehicle and a detection unit for use therein

The invention relates to a detection system for detecting a gas pressure, particularly a reduced gas pressure, in a tyre of a vehicle.

It is very important for the tyres of a vehicle to have the correct pressure. If a vehicle such as for instance a truck, bus or car has a puncture, it is necessary to stop driving as quickly as possible to change this tyre since otherwise the tyre will be so badly damaged that it can no longer be repaired. It is further of great importance to detect whether the gas pressure of the tyres is too low, since this results in increased fuel consumption and, after a longer period of time, possible damage to the tyres.

It can be the case, particularly in the case of large vehicles, that during driving it is difficult for the driver to ascertain whether a tyre of for instance a rear wheel is punctured or too soft. Particularly in the case of articulated trucks consisting of a truck and a trailer it is practically impossible during driving for the driver to detect a punctured tyre or too soft tyre on the trailer. Likewise in the case of a vehicle with trailer, it is very difficult to ascertain whether a tyre of the trailer is punctured or is too soft.

A detection system known heretofore consists only of a visual inspection of the tyres when the vehicle is at a standstill.

The invention has for its object inter alia to provide a detection system which enables detection of a punctured or too soft tyre of the vehicle during both travel and standstill. To this end a detection system according to the invention has the feature that the detection system comprises a detection unit and a display unit coupled to the detection unit, wherein the detection unit is adapted to detect gas pressure information of the tyre and to generate a detection signal which depends

on the detected gas pressure information, and wherein the display unit is adapted to display a display signal which depends on the detection signal.

It hereby becomes possible during driving for a driver to ascertain via the display unit, for instance in the cab, whether a tyre has been punctured or become too soft, whereby the vehicle is stopped before the tyre is damaged further. If the tyre is punctured, it can then be changed. If the punctured tyre is a tubeless tyre, it can be repaired at minimal cost, for instance at a garage, using a so-called plug. If an inner tube is present, it can be patched.
If only the tyre pressure is too low, the tyre can be brought to pressure again on the spot or later after replacement. When the gas pressure in a tyre is too high, gas can be released from the tyre.

An embodiment of a detection system according to the invention has the feature that the detection unit contains a gas communication channel for detecting gas pressure information at a distance from an internal, gas-filled space of the tyre.

The gas communication channel results in a direct relation between the gas pressure in the tyre and the gas pressure detected in the detection unit.

An embodiment of a detection system according to the invention has the feature that the detection unit with the gas communication channel is coupled to a wheel rim which is provided with an opening and on which the tyre is situated.

By connecting the gas communication channel to an opening arranged in the rim of the tyre, the air pressure in the tyre is immediately available in the gas communication channel for detecting of a gas pressure.

An embodiment of a detection system according to the invention has the feature that the detection unit with the gas communication channel is coupled to a valve of the tyre.

It is hereby possible to apply the detection system both for tubeless tyres and for tyres provided with an inner tube.

An embodiment of a detection system according to the invention has the feature that the detection unit in the gas communication channel is provided with a membrane and spring means, which spring means exert pressure from one side on the membrane during operation and the gas pressure of the tyre exerts pressure on the membrane from the other side.

As long as the gas pressure in the tyre corresponds with the predetermined gas pressure associated with this tyre, the membrane will be situated in the rest position. If the gas pressure in the tyre falls, the membrane will be displaced from the rest position and, as a result hereof, the detection unit will detect the reduced gas pressure.

The membrane and the spring means can be adjusted such that the detection unit generates a detection signal at a predetermined gas pressure in the tyre. The detection unit can also be adapted per type of tyre and/or type of vehicle by the choice of the membrane and the spring means.

An embodiment of a detection system according to the invention has the feature that the detection unit in the gas communication channel is provided with a movable valve and spring means, which spring means exert pressure on the valve from a first side and the gas pressure of the tyre exerts pressure on the valve from the other side.

A movable valve is included in this embodiment as alternative to the membrane. A more robust embodiment is hereby obtained.

An embodiment of a detection system according to the invention has the feature that the detection unit contains a position detector for generating a signal subject to the detected gas pressure.

The position detector functions as a switch and indicates whether the gas pressure in the tyre has changed.

An embodiment of a detection system according to the invention has the feature that the detection unit contains a pressure sensor coupled to the gas communication channel for detecting the gas pressure in the tyre.
With a pressure sensor it is not only possible to detect a change in the gas pressure but also, if required, to continuously determine the precise gas pressure in the tyre.

An embodiment of a detection system according to the invention has the feature that the detection system comprises a transmitter connected to the detection unit and a receiver connected to the display unit for wireless transmission of a transmission signal related to the detection signal.

The reliability of the detection system is increased by wireless transmission with the transmitter of a signal related to the detection signal from the wheel to the receiver connected to the vehicle.

A further embodiment of a detection system according to the invention has the feature that the detection system contains a power supply coupled to the transmitter for providing the transmitter with energy.

The power supply must be adapted subject to the amount of energy required for transmitting the transmission signal to the receiver. The power supply may for instance contain a battery.

A further embodiment of a detection system according to the invention has the feature that the power supply comprises a coil and a magnet, wherein the magnet and the coil move relative to each other during rotation of the tyre in order to generate a supply voltage.

It hereby becomes possible to generate a voltage without making use of batteries, whereby an operationally reliable power supply is obtained which requires no external energy.

Another embodiment of a detection system according to the invention has the feature that the power supply contains a motor which is provided on a drive shaft with a weight element, wherein the motor generates energy during rotation of the tyre.

By employing the motor as generator it is possible to generate energy for the transmitter in simple manner. The weight element will be situated substantially close to the lowest position, whereby the drive shaft rotates relative to a motor housing of the motor. The motor hereby acts as generator.

An embodiment of a detection system according to the invention has the feature that the detection system comprises a detection unit and a transmitter per tyre which has to be monitored.

It hereby becomes possible to determine per type of vehicle which tyres have to be monitored and to then provide these tyres and wheel rims with a detection unit and a transmitter.

A further embodiment of a detection system according to the invention has the feature that during operation each of the transmitters transmits a mutually differing transmission signal and the receiver is adapted to receive the different transmission signals.

By causing each transmitter to transmit a different transmission signal it becomes possible to operate with one receiver for all transmitter units, which is advantageous from a cost viewpoint and in decreasing complexity.

The invention also relates to a detection unit, a transmitter and a receiver for use in such a detection system.

The invention will be further elucidated hereinbelow by way of example with reference to the annexed figures. Herein:

figure 1 shows a schematic embodiment of a detection system according to the invention,

figure 2 shows a schematic embodiment of a detection unit and of a power supply of a detection system according to the invention,

figure 3 shows a schematic embodiment of a detection unit coupled to a valve of a tyre and of a power supply of a detection system according to the invention, and

figure 4 shows a preferred embodiment of a detection unit and transmitter of a detection system according to the invention.

Figure 1 shows an embodiment of a detection system 1 for detecting a reduced gas pressure in a tyre of a vehicle. The detection system comprises a detection unit 3, a transmitter 5, a receiver 7 and a display unit 9. Such a detection system can be applied in a vehicle such as a truck, a truck with trailer and the like to detect if the gas pressure of one or more of the tyres is too soft and which tyre may be punctured. Particularly in the case of large vehicles it may be difficult for the driver to ascertain whether one of the tyres is too soft and possibly punctured. If driving continues with the punctured tyre this will be damaged such that repair thereof is no longer possible.
In addition, the fuel consumption of a vehicle with too soft tyres is considerably higher than with tyres having the correct tyre pressure.

The detection unit receives a gas pressure information signal gdi from a tyre B. After detection of a reduced gas pressure in the tyre the detection unit generates a detection signal ds to transmitter 5.

In this embodiment detection unit 3 and transmitter 5 are mounted on the wheel rim of the tyre of which a possible fall in the gas pressure has to be detected. This location is indicated in the figure with the reference numeral 11.

The transmitter unit wirelessly generates a transmission signal zs to receiver 7. This signal is shown in figure 1 as a broken line.
This transfer of the transmission signal zs must preferably take place in wireless manner since during travel the tyre rotates continuously. Slide contacts could for instance be used as alternative, although the reliability thereof is often insufficient under the frequently heavy conditions in which such a detection system has to function.
The energy required for generating and emitting the transmission signal zs can be obtained in different ways. The transmitter can for instance be provided for instance with a battery which should preferably have a long lifespan such that the battery can for instance be replaced simultaneously with changing of the tyre once the tyre is worn out. Figures 2, 3 and 4 show other options for obtaining the required energy.

In this embodiment receiver 7 receives the transmission signal from one transmitter, although it will be apparent that it is possible to apply a detection unit and a transmitter per tyre for monitoring, which transmitter units send mutually differing transmission signals to receiver 7. It is hereby possible to extend the detection system subject to the number of tyres for detecting. The receiver generates a signal os to the display unit depending on the received transmission signal zs (or on the received transmission signals). The receiver must preferably be mounted on the vehicle in the vicinity of transmitter 5 in order to ensure that the transmitter need use as little energy as possible to send the transmission signal to the receiver. The designation of this location is indicated in the figure with the reference numeral 13.

Display unit 9 provides the driver of the vehicle information concerning the state of the gas pressure of one or more tyres. The display unit will therefore usually also be placed in the vicinity of the driver in order to alert the driver visually, auditively

or otherwise that one or more tyres are too soft and possibly punctured. The designation of this location is indicated in figure 1 with the reference numeral 15.

Figure 2 shows in more detail an embodiment of the detection unit 3 of detection system 1 of figure 1. The figure further shows an embodiment of a power supply 4 for generating the energy required for transmitter 5 (see figure 1). The detection unit is mounted in this embodiment through the wheel rim V of tyre B (see figure 1) and contains a sleeve 31 which protrudes through the rim and is fastened thereto with a nut 32. The detection unit further contains a valve 33 which is carried through sleeve 31. The sleeve is also provided internally with a spring 35 which exerts a spring fore on the valve to push the valve to the inner side of the tyre. The gas pressure of the tyre provides a counterpressure and ensures that, as long as the gas pressure in the tyre is high enough, the valve remains closed. Finally, the detection unit contains a position detector 37 which operates for instance as switch and passes to the transmitter information in the form of a detection signal ds concerning the position of the valve (see figure 1).

Instead of a valve it is also possible to use a membrane to detect a reduced gas pressure in the tyre. In this embodiment the position detector 37, operating for instance as switch, also generates a detection signal.

Power supply 4 for providing transmitter 5 with energy contains in this embodiment a housing 41, an eccentric fly-wheel 43 with a fly-wheel shaft 42 and two coils 45 mounted in the housing.
A permanent magnet 47 is mounted on fly-wheel 43. The fly-wheel will begin to rotate due to the rotation of the wheel rim during driving of the vehicle, whereby the magnetic field in the vicinity of the two coils will alternate continuously. Hereby excited in the coils is a current which can provide the transmitter with energy.

Figure 3 shows another embodiment for mounting detection unit 3' on the already present valve of the tyre. In this embodiment a pressure sensor 37 is screwed for

this purpose onto valve 51 with a screw connection 52, which pressure sensor is further connected to the transmitter with a thin cable (not shown) for transfer of detection signal ds. The pressure sensor can be embodied, if required, such that it can measure the gas pressure and therewith the tyre pressure to an accuracy of 0.1 bar.

An advantage of this latter embodiment is that the detection system is hereby applicable on tyres with or without inner tubes. In addition, it is structurally simpler since no extra opening has to be made in the rim.

Power supply 4 is embodied in the same way as in figure 2 and therefore also designated with the same reference numerals.
Figure 3 also shows two supports 53 for housing 41 of power supply 4 for supporting the power supply during rotation of the rim.

Transmitter 5 can for instance be placed on the bearing of the wheel. The transmitter is hereby placed in or close to the centre of the rim, and thus the wheel, whereby no imbalance of the wheel will occur, and such imbalance will not therefore have to be corrected.

Figure 4a shows schematically a preferred embodiment of a combined detection and transmitter unit 2, comprising a pressure sensor 21 coupled to a basic unit 25 with a reinforced cable 23.
Pressure sensor 21 is coupled to a valve nut 51' for receiving gas pressure information from the tyre. The pressure sensor transmits the gas pressure of the tyre to basic unit 25 via cable 23, which basic unit is preferably mounted on the wheel bearing.

Figures 4b and 4c show respectively in section and in cross-section the basic unit 25 of figure 4a. The basic unit contains a connection 251 for cable 23. The received signal is fed via an A/D converter 252 and a filter unit 253 to a processor

processor converts the signal into a form suitable for transmission. The signal is transmitted with an antenna A (see figure 4c).

In this embodiment basic unit 25 further contains an identification chip 255 which ensures that the transmission signals from the different transmitter units are different when a plurality of detection units are used.

In the embodiment of figure 4 the energy required to transmit the transmission signal of transmission signals to the receiver(s) is obtained using a motor 256 operating as generator, for instance a stepping motor. The motor is provided with a drive shaft to which is coupled a weight element G. During rotation of the wheel the weight element will remain directed downward at all times, whereby the drive shaft rotates relative to the housing of motor unit 256.
The motor unit hereby generates a voltage, which voltage is stored in a battery 258 via a dynamo 257.
Because the battery is continuously charged during driving it is also possible, even before driving away, to display to the driver the gas pressure in the tyres and therewith the tyre pressure of all tyres.

Transmitter unit 5 can preferably send the transmission signal zs wirelessly to receiver 7 in different ways. This can for instance take place radiographically, ultrasonically etc.

In an even further advanced embodiment, the receiver can be embodied such that, when the detection system is first started up on the basis of a code which is provided for instance by identification chip 255 and is co-transmitted with the transmission signal, this receiver itself determines from which transmitter units and thus from which tyres these signals have come.

Although the invention is elucidated with reference to these embodiments, it will be apparent to all that the invention is in no way limited to the given examples. On the

contrary, many more variations and embodiments are possible for a skilled person within the scope of the invention.

Claims

1. Detection system for detecting a gas pressure, particularly a gas pressure in a tyre of a vehicle, **characterized in that** the detection system comprises a detection unit and a display unit coupled to the detection unit, wherein the detection unit is adapted to detect gas pressure information of the tyre and to generate a detection signal which depends on the detected gas pressure information, and wherein the display unit is adapted to display a display signal which depends on the detection signal.

2. Detection system as claimed in claim 1, **characterized in that** the detection unit contains a gas communication channel for detecting gas pressure information at a distance from an internal, gas-filled space of the tyre.

3. Detection system as claimed in claim 2, **characterized in that** the detection unit with the gas communication channel is coupled to a wheel rim which is provided with an opening and on which the tyre is situated.

4. Detection system as claimed in claim 2, **characterized in that** the detection unit with the gas communication channel is coupled to a valve of the tyre.

5. Detection system as claimed in claim 2, 3 or 4, **characterized in that** the detection unit in the gas communication channel is provided with a membrane and spring means, which spring means exert pressure on the membrane from a first side during operation and the gas pressure of the tyre exerts pressure on the membrane from the other side.

6. Detection system as claimed in claim 2, 3 or 4, **characterized in that** the detection unit in the gas communication channel is provided with a movable valve and spring means, which spring means exert pressure on the valve from a first side and the gas pressure of the tyre exerts pressure on the valve from the other side.

7. Detection system as claimed in claim 5 or 6, **characterized in that** the detection unit contains a position detector for generating a signal subject to the detected gas pressure.

8. Detection system as claimed in claim 2, 3 or 4, **characterized in that** the detection unit contains a pressure sensor coupled to the gas communication channel for detecting the gas pressure in the tyre.

9. Detection system as claimed in one or more of the foregoing claims, **characterized in that** the detection system comprises a transmitter connected to the detection unit and a receiver connected to the display unit for wireless transmission of a transmission signal related to the detection signal.

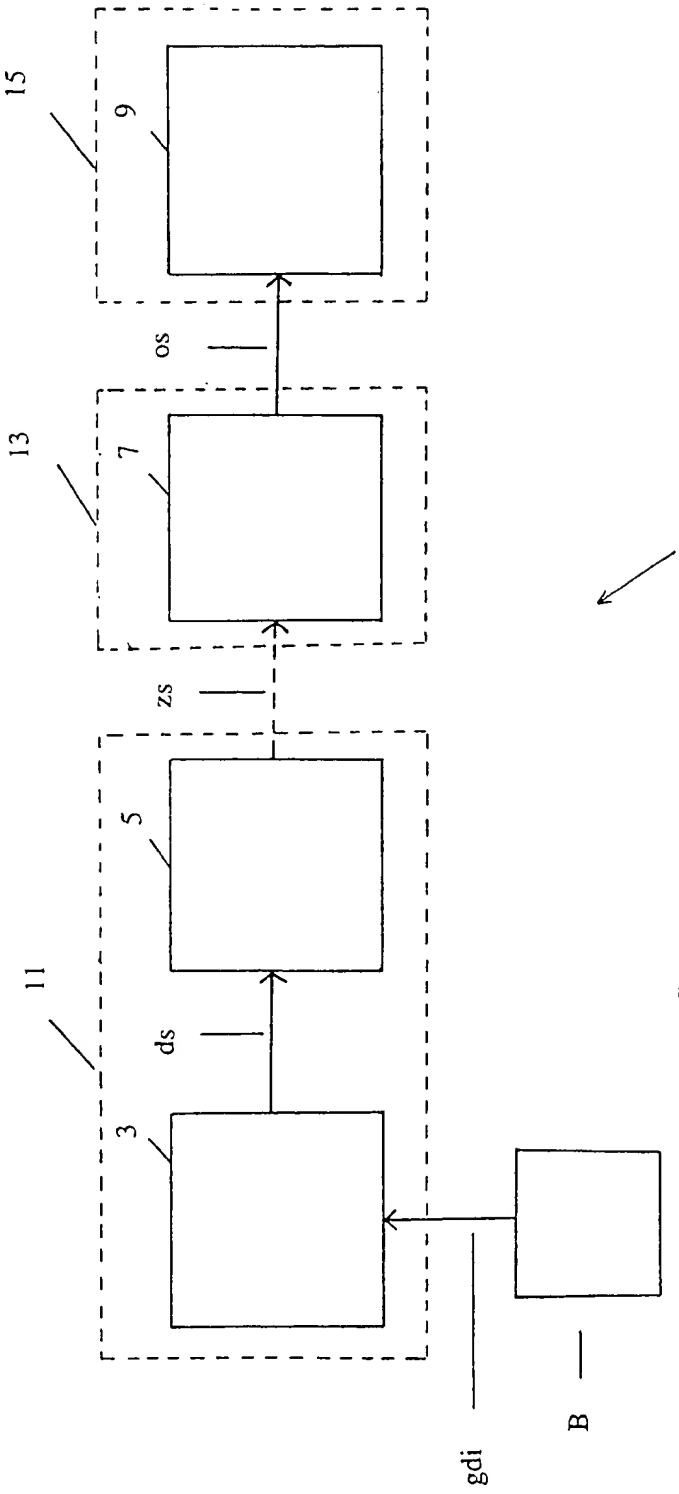
10. Detection system as claimed in claim 9, **characterized in that** the detection system comprises a power supply coupled to the transmitter for providing the transmitter with energy.

11. Detection system as claimed in claim 10, **characterized in that** the power supply comprises a coil and a magnet, wherein the magnet and the coil move relative to each other during rotation of the tyre in order to generate a supply voltage.

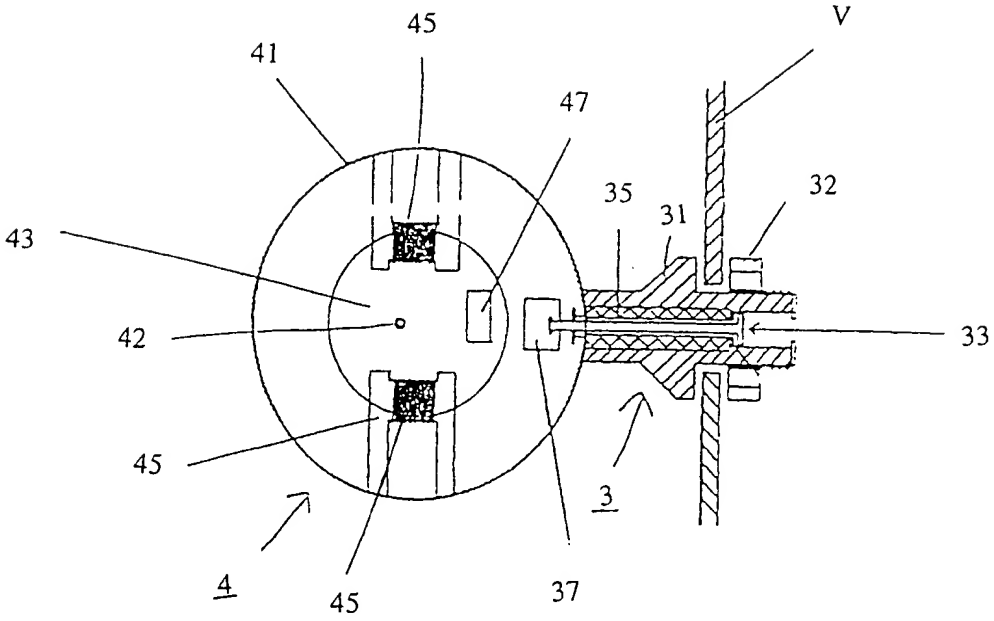
12. Detection system as claimed in claim 10, **characterized in that** the power supply contains a motor which is provided with a weight element on a drive shaft, wherein the motor generates energy during rotation of the tyre.

13. Detection system as claimed in claim 9, 10, 11 or 12, **characterized in that** the detection system comprises a detection unit and a transmitter per tyre which has to be monitored.

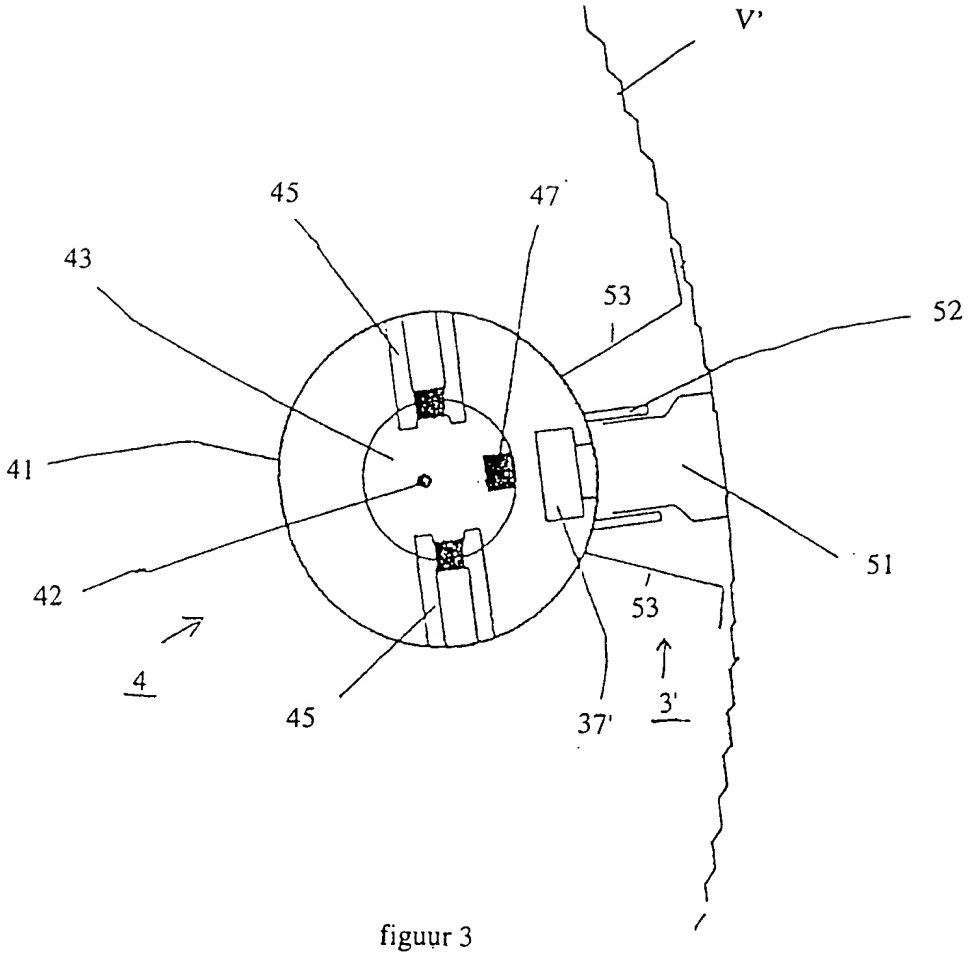
14. Detection system as claimed in claim 13, **characterized in that** during operation a plurality of transmitters transmit a mutually differing transmission signal and a single receiver is adapted to receive the different transmission signals.



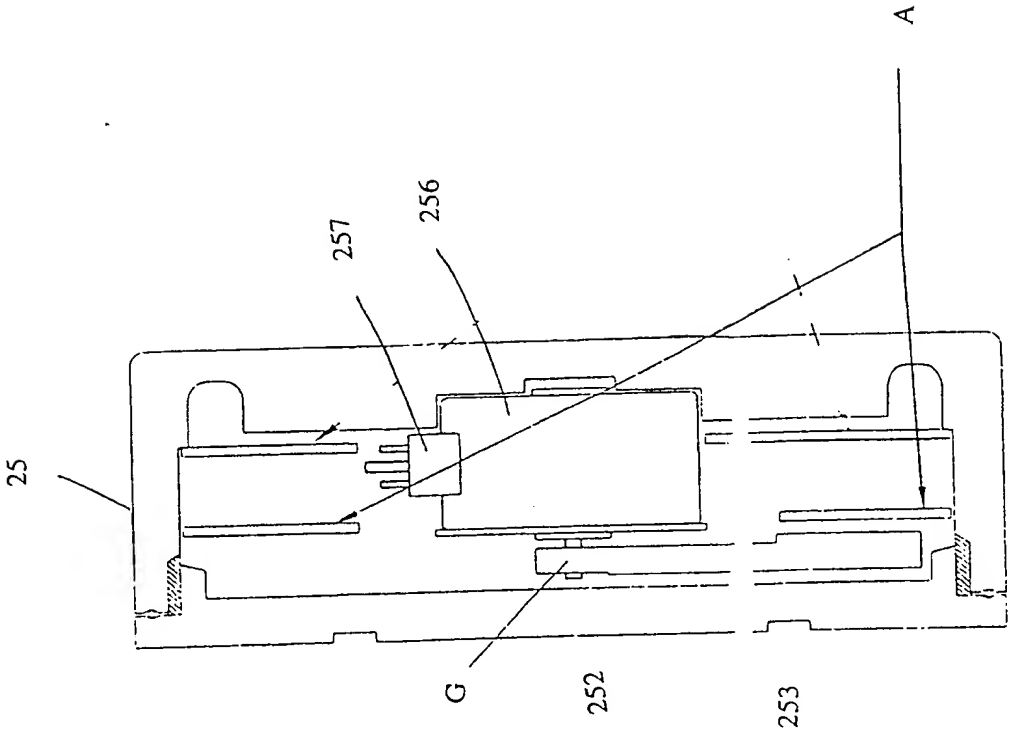
figuur 1



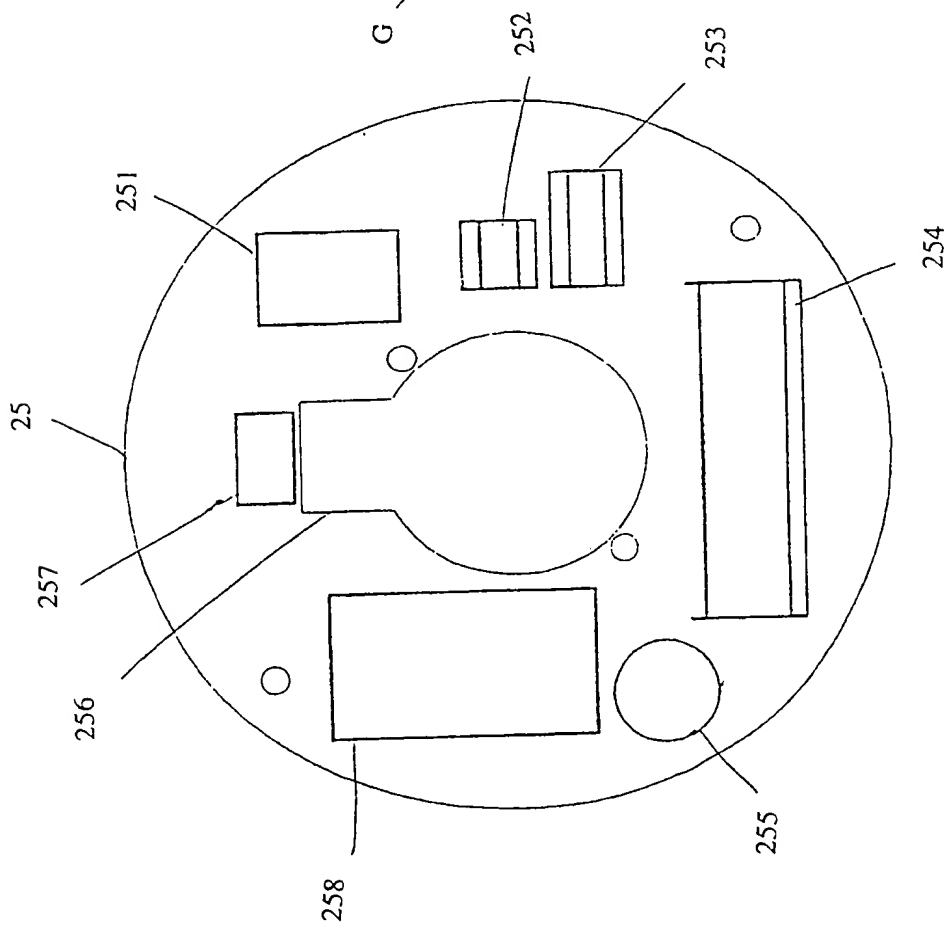
figuur 2



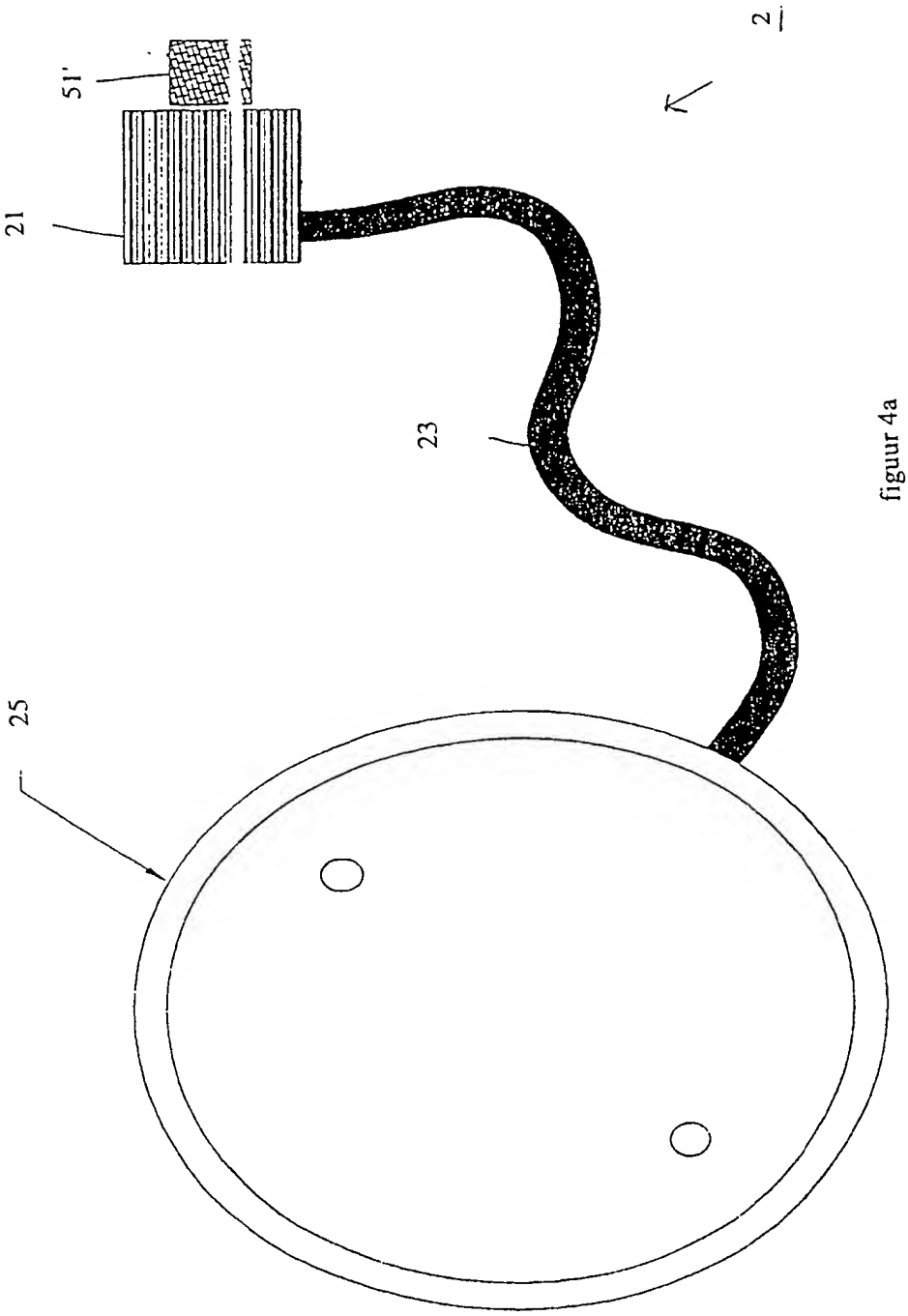
figuur 3



figuur 4c



figuur 4b



figuur 4a

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/NL 98/00379

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60C23/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category ³	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 075 603 A (SNYDER DANIEL S ET AL) 21 February 1978 see column 1, line 43 - column 10, line 48; figures	1-13
X	WO 87 01527 A (ANTONELLO LUIS MARIA) 12 March 1987 see page 3, line 16 - page 10, line 16; figures	1-4,8-14
X	US 4 300 120 A (SURMAN JAMES J) 10 November 1981 see column 3, line 33 - column 5, line 23; figures	1-3,8-13

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
5 October 1998	09/10/1998

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

information on patent family members

Inte onal Application No
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